CLAIMS

What is claimed is:

1. A method of modeling a thin film resistor in an integrated circuit, comprising:

fabricating the thin film resistor over a substrate and a dielectric;

characterizing a thermal resistance of the thin film resistor, wherein the thermal resistance accounts for self-heating thereof during operation; and

using the thermal resistance in a model for use in simulating integrated circuits using the thin film resistor.

2. The method of claim 1, wherein characterizing the thermal resistance of the thin film resistor comprises:

measuring dimensions of the thin film resistor; and

calculating an approximation of the thermal resistance using the measured dimensions.

3. The method of claim 2, wherein calculating the approximation of the thermal resistance comprises calculating the thermal resistance according to the formula:

$$r_{th} = z/\lambda LW,$$

wherein r_{th} is the thermal resistance, z is a thickness of an electrically insulating layer overlying the substrate on which the thin film resistor resides, λ is the thermal conductivity distribution associated with the thin film resistor, and L and W is the length and width of the thin film resistor, respectively.

4. The method of claim 2, wherein calculating the approximation of the thermal resistance comprises calculating the thermal resistance according to the formula:

$$r_{th} = z/\lambda\alpha LW,$$

wherein r_{th} is the thermal resistance, z is a thickness of an electrically insulating layer overlying the substrate on which the thin film resistor resides, λ is the

thermal conductivity distribution associated with the thin film resistor, and L and W is the length and width of the thin film resistor, respectively, and α is a fit parameter that accounts for a temperature gradient associated with a top portion of the thin film resistor being nonzero.

5. The method of claim 2, wherein calculating the approximation of the thermal resistance comprises calculating the thermal resistance according to the formula:

$$r_{th} = z/\lambda(LW + 2H(L + W)),$$

wherein r_{th} is the thermal resistance, z is a thickness of an electrically insulating layer overlying the substrate on which the thin film resistor resides, λ is the thermal conductivity distribution associated with the thin film resistor, and L, W and H are the length, width and height of the thin film resistor, respectively.

6. The method of claim 1, further comprising fabricating a plurality of thin film resistors of the same type, wherein the plurality of thin film resistors have varying dimensions associated therewith.

7. The method of claim 6, wherein characterizing the thermal resistance of the thin film resistor comprises:

measuring a voltage coefficient of the plurality of thin film resistors, thereby resulting in voltage coefficient data that reflects a change in resistance of the thin film resistors based on variations in applied voltage thereto; and

using the voltage coefficient data to extract fit parameters to characterize the thermal resistance.

8. The method of claim 7, wherein characterizing the thermal resistance of the thin film resistor comprises:

extracting the fit parameters using the voltage coefficient data according to the formula:

$$r_{th} = z/\lambda(\alpha LW + 2\beta H(L + W) + \gamma),$$

wherein alpha, beta and gamma comprise the fit parameters.

9. The method of claim 8, wherein α comprises a fit parameter that accounts for a temperature gradient associated with a top portion of the thin film resistors being nonzero, β accounts for the temperature gradient associated with the peripheral portions of the thin film resistors being different than the temperature gradient associated with bottom portions thereof, and γ is a fit parameter that accounts for heat loss area associated with head portions of the thin film resistor.

10. The method of claim 6, wherein characterizing the thermal resistance of the thin film resistor comprises:

measuring a current coefficient of the plurality of thin film resistors, thereby resulting in current coefficient data that reflects a change in resistance of the thin film resistors based on variations in current conducting therethrough; and

using the current coefficient data to extract fit parameters to characterize the thermal resistance.

11. A method of modeling a bar-shaped thin film resistor, comprising:

forming a plurality of thin film resistors of differing sizes;

measuring a voltage or current coefficient of the plurality of thin film resistors; and

determining a thermal resistance based on the measured voltage or current coefficients.

12. The method of claim 11, wherein measuring the voltage coefficients comprises:

applying a voltage of varying magnitude across the plurality of thin film resistors; and

measuring a change in resistance of the plurality of thin film resistors as a function of the varied applied voltages.

13. The method of claim 11, wherein measuring the voltage coefficient comprises:

distilling body voltage coefficient data from head voltage coefficient data in the measured voltage coefficients; and

using the body voltage coefficient data to determine one or more fit parameters for a thermal resistance model.

14. The method of claim 11, wherein determining the thermal resistance comprises:

assuming an initial thermal resistance value;

using the assumed initial thermal resistance value to distill body voltage coefficient data from the measured voltage coefficients;

determining one or more fit parameters from the body voltage coefficient data; and

using the determined fit parameters to calculate a new thermal resistance value.

15. The method of claim 14, further comprising:

(a) using the new thermal resistance value to distill new vody voltage coefficient data from the measured voltage coefficients;

(b) determining new fit parameters from the new body voltage coefficient data; and

(c) using the new fit parameters to calculate an updated thermal resistance value.

16. The method of claim 15, further comprising repeating the actions (a), (b) and (c) until the current new fit parameters differ from a previous set of fit parameters by a predetermined amount or less.

17. The method of claim 15, further comprising repeating the actions (a), (b) and (c) a predetermined number of times.

18. The method of claim 14, wherein determining the one or more fit parameters comprises:

calculating a voltage coefficient of the head for each of the plurality of thin film resistors using the initial assumed thermal resistance according to the formula:

$$V_{CR\_h} = 2R_h T_{CR\_h} r_{th}/(R_{t0}W),$$

wherein V_{CR_h} is the voltage coefficient of the head, R_h is the head resistance, T_{CR_h} is the temperature coefficient of the head, r_{th} is the initial assumed thermal resistance, R_{t0} is a total resistance without a voltage applied thereto, and W is a width of the thin film resistor.

19. The method of claim 18, further comprising subtracting the voltage coefficient of the head from the voltage coefficient for each of the plurality of thin film resistors to obtain the voltage coefficient of the body for each of the thin film resistors.

20. The method of claim 19, calculating fit parameters using the voltage coefficient of the body data according to the formula:

$$V_{CR\_b} = W\alpha_p/((W + \beta_p)L^2 + (W\beta_p + \gamma_p)L),$$

wherein V_{CR_b} is the voltage coefficient of the body and α_p, β_p, and γ_p comprise preliminary fit parameters.

21. The method of claim 20, wherein the one or more fit parameters are calculated by:

$\alpha = T_{CR\_b}z/\lambda\alpha_p R_{sh}$, $\beta = \alpha\beta_p/2H$ and $\gamma = \alpha\gamma_p$,

wherein α comprises a fit parameter that accounts for a temperature gradient associated with a top portion of the thin film resistors being nonzero, β accounts for the temperature gradient associated with the peripheral portions of the thin

film resistors being different than the temperature gradient associated with bottom portions thereof, and γ is a fit parameter that accounts for heat loss area associated with head portions of the thin film resistor.